Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona New Mexico, and Utah

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River and to its larger tributaries. Ground-water movement north of the San Juan River is downdip toward the center of the Henry basin and to the Colorado River.

KAIPAROWITS BASIN

All movement of ground water in the Kaiparowits basin is toward the Colorado and San Juan Rivers (pl. 5). The Navajo Sandstone is the chief aquifer and is recharged nearly everywhere within the basin. South of the Colorado River in the Navajo Indian Reservation, ground water in the Navajo is generally unconfined, but the water north of the river near the center of the basin is confined. In the southern part of the Kaiparowits basin, the Navajo Sandstone is the only aquifer that adjoins the streambed between the mouth of Forbidding Canyon and Lees Ferry (pl. 1) and discharges directly to the Colorado River.

In the eastern part of the basin, the Navajo Mountain dome and nearby deep canyons modify the general northwestward ground-water movement toward the Colorado River. Movement from Navajo Mountain is radial in all directions except to the northeast, where the domal structure joins the Beaver Creek and Rainbow anticlines. Ground water in the Navajo and Wingate Sandstones discharges along the rim of Piute Canyon and into the bottoms of Forbidding and Navajo Canyons. In this area the N multiple-aquifer system is well developed, and much of the water that is recharged to the Navajo Sandstone percolates downward through the Kayenta Formation and into the Wingate Sandstone. This interformational movement is aided by strong jointing and fracturing and by zones of shattered rock on Navajo Mountain.

Rocks of Jurassic age contribute very little water to the Colorado River in the Kaiparowits basin because they crop out high on the mesas, buttes, and escarpments. Ground-water movement is localized, and there are a few springs on Navajo Mountain, on the downdip sides of mesas, and in a few places elsewhere in the basin.

DISCHARGE

The main areas of natural ground-water discharge in the Navajo country adjoin the Colorado, San Juan, Chaco, and Little Colorado Rivers, Moenkopi and Chinle Washes, and Navajo Creek (pl. 5). This water becomes part of the streamflow. The total amount of ground water discharged into the Colorado River system is unknown, although 223 cfs has been measured near the mouth of the Little Colorado River, and more than 8 cfs is estimated to be maintaining the flow in the perennial reaches of tributaries flowing into the Colorado River in Glen Canyon and into the San Juan River. In addition, the combined total flow of the perennial reaches of streams in the interior of the reservations was partly measured and is estimated to be about 10 cfs. Most of this flow percolates into the sandy alluvium or is evaporated.

Few springs in the reservations yield more than 10 gpm, and this water is evaporated near the points of discharge. Several springs at Hotevila in the Hopi country furnish enough water to irrigate small terraces built on the nearby rocky cliffs. The total discharge of the springs, excluding that of Blue Spring, is not more than 20 cfs. The main areas of spring discharge are in the canyons adjacent to Glen Canyon, near Tuba City, near Mexican Water, on the Defiance Plateau, and in the Chuska and Carrizo Mountains.

Most springs on the reservations are gravity springs, where the water table intersects the land surface. The common types are contact, fracture, depression, tubular, and seepage. Few of the springs are artesian and no thermal springs were inventoried. Generally the water of an artesian spring flows through an opening in the confining beds overlying the aquifer. These springs are principally in the area of artesian flow along the west side of the San Juan basin (fig. 9), although gravity springs are more common throughout this area.

Contact springs occur principally along the lower contacts of the Navajo Sandstone, Shinarump Member of the Chinle Formation, Lukachukai Member of the Wingate Sandstone, Dakota Sandstone, Chuska Sandstone, volcanic member of the Bidahochi Formation, and the sandstone units of the Mesaverde Group. Numerous springs also discharge along the contact between the alluvium and impermeable consolidated rock units.

Fracture springs flow from joints, faults, and bedding planes. These are the most common types in the Navajo, Wingate, and other thick sandstone units. Large bedding planes, concave upward in the Navajo Sandstone and the Shinarump Member of the Chinle Formation, concentrate downward-percolating ground water, which is discharged usually as small perched springs or seeps, in places hundreds of feet above the regional water table—in some places high on the side of a cliff. Weathering of the Navajo Sandstone in the immediate area of a spring issuing along joints and bedding planes has produced many of the prominent numerous alcoves in the canyon country near the Colorado River.

Tubular springs are rare; these include only Blue Spring and a few associated springs that flow from limestone within the canyon of the Little Colorado River. In the past, however, tubular openings of diatremes in the Hopi Buttes and on the Defiance Plateau also were the orifices of large extinct springs (pl. 1).